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CONSERVATION OF THE SARUS CRANE *GRUS ANTIGONE* IN UTTAR PRADESH, INDIA

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Uttar Pradesh is known to be crucial for the conservation of Sarus Cranes, though empirical information from the State has not been forthcoming. In this paper, information on the status of Sarus Cranes in all-India surveys and counts have been used to demonstrate that Uttar Pradesh is presently the most important state for the Sarus Crane. A relative abundance map prepared using these data shows that many of the cranes are concentrated in the western and central portion of the State. Breeding records are available from almost the entire State. Findings of detailed ecological studies, carried out in Etawah and Mainpuri districts during 1999-2002, have been used to demonstrate how natural wetlands are crucial to maximise breeding success in the species. Pairs that had territories with more number of natural wetlands and those with perennial wetlands were more successful in raising young. Habitat use information revealed that natural wetlands are preferred as nesting sites, as well as for foraging. The future of Sarus Cranes in Uttar Pradesh will depend on how well the State is able to preserve its natural wetlands of all sizes.

Key words: conservation, Sarus Crane, status, Uttar Pradesh

INTRODUCTION

History and distribution

The Indian subspecies of the Sarus Crane *Grus antigone antigone* is one of the commonest species of large waterbirds in the *chaurs* of the Gangetic floodplains. The sheer size and habits of the birds such as staying in pairs have elicited the interest of poet and emperor alike. The very first reference to the species is in the Hindu epic *RAMAYAN* by Valmiki. The observation took place in Allahabad, Uttar Pradesh on the banks of the Ganga when Valmiki observed a hunter killing one of a pair of dancing Sarus Cranes, and angered by the act of the hunter, cursed him (Leslie 1998). Also well known are the accurately maintained records of the Emperor Jehangir, who observed and maintained accounts of the natural history of the Sarus and was perhaps the first person to individually mark birds by placing rings on the noses of a few of them that he maintained free-flying (Ali 1927). It is commonly believed that Sarus Cranes pair for life, and several accounts of "faithfulness" and birds staying on beside their dead partners until they themselves die are present in literature. Adam (1872), writing on the protection afforded to the species by the farming community notes the following: "Although the people of Rajputana do not worship the bird, they object to its being shot, and they look upon the killing of the pair as the lesser sin than the killing of one. Should one of a pair be killed, the native belief is that the surviving bird calls all night long for its mate, and beats its head on the ground until it dies." These accounts have given rise to several myths about the Sarus in the north

and central Indian countryside. The species is accorded iconic status in several areas and is zealously protected. The Sarus Crane is one of the few species of cranes known to coexist readily alongside human habitation (Meine and Archibald 1996) and is inseparable from the paddy fields of the Indo-Gangetic flood plains. Farmers in Uttar Pradesh have long been known to be sympathetic to the Sarus and allow them to nest in rice fields, and protect nests that are built in village ponds beside rice fields.

In India, Sarus cranes are most commonly found in Uttar Pradesh, Gujarat and Rajasthan, in that order, and smaller numbers can be counted in Madhya Pradesh, Maharashtra, Haryana, Himachal Pradesh, Jammu and Kashmir, West Bengal and Assam (Gole 1989; Sundar *et al.* 2000b). They seem to have been hunted out in Bihar and intensification of agriculture seems to have removed them from Punjab for many decades now (BirdLife International 2001). However, nowhere is the species as commonly found as in Uttar Pradesh and the State has recognised this by officially declaring the species as the State Bird. The Sarus Crane was a close contender for National Bird status in India and it was only the large-scale popular appeal of the Peafowl *Pavo cristatus* that tilted the decision in favour of the latter (Himmatsinhji, pers. comm.).

Status and ecology

In spite of being a very common species in the Indian countryside and being the tallest flying species of bird in the world, the Sarus was very strangely not accorded any scientific attention except for a few anecdotal observations.

on the diet and nidification of the birds in the *Journal of the Bombay Natural History Society*. Most of the published observations on the behaviour and ecology of the species are accounts from Rajasthan (Ali 1958; Gole 1997; Ramachandran and Vijayan 1994; Vyas 1999b) and recently from Gujarat (Borad *et al.* 2001; Mukherjee *et al.* 2002). The credit for initiating work on the ecology and requirements of the Sarus Crane goes to Prakash Gole who carried out the first all-India survey to determine the status of the species (Gole 1989) in addition to making the first detailed observations on territoriality and breeding success of pairs in Keoladeo National Park, Rajasthan (Gole 1997). He discovered many hitherto unknown facts about the species in addition to making the first estimation of population of the Sarus in the country. He also provided the first empirical evidence that much of the population of Sarus Cranes exists outside protected areas, indeed in private crop fields in the country. He surmised that the decline in natural wetlands all over the country was responsible for forcing Sarus Cranes to use crop fields to such a high extent, and that this shift may not favour the survival of the species. Another survey, carried out exactly a decade later by the Wildlife Institute of India (WII) (Sundar *et al.* 2000b), discovered that the overall distribution of the Sarus Crane was a little larger than previously thought, but more importantly, found that the numbers (represented as encounter rates) of Sarus Cranes in several areas were much lower than that estimated by Gole (1989). It appeared that the species was losing ground in many places particularly Gujarat, Rajasthan, Madhya Pradesh and the northern parts of Uttar Pradesh. Interviews with farmers during the survey showed that many more people than previously known were beginning to consider the Sarus Cranes as pests (Sundar *et al.* 2000b). The highest counts were in Uttar Pradesh, but more than 50% of the 579 people interviewed in this State during the survey regarded the birds as pests and more than 75% of the cranes were seen in crop fields. In addition to these all-India surveys, three Sarus counts have been organised by the WII (Choudhury *et al.* 1999; Sundar *et al.* 2000a; Kaur *et al.* 2002), and several state-level and district-level surveys have been undertaken by many organisations (e.g. Singh and Tatu 2000; Vyas 1999a). The Sarus Crane is presently protected by the Indian Wildlife (Protection) Act, 1972 under Schedule IV, and is designated as globally threatened (BirdLife International 2001).

All the previous studies have contended that crop fields may be affecting the Sarus Crane adversely and may cause reduction in clutch sizes (Ramachandran and Vijayan 1994) and reduced breeding success (Mukherjee *et al.* 2002). However, empirical evidence that crop fields are sub-optimal habitats for Sarus Cranes has not been

forthcoming. Also, basic information on habitat use/preference by Sarus Cranes is not available and it is not known if the cranes being seen increasingly in crop fields are in fact forced or otherwise. The WII initiated a study in Etawah and Mainpuri districts in Uttar Pradesh between December 1999 to July 2002 to study the biology of the Sarus in the State and specifically to determine the effects of changing land use patterns, particularly the conversion of natural wetlands to crop fields. This paper documents the importance of Uttar Pradesh to Sarus Cranes and demonstrates how natural wetlands are crucial habitats for the Sarus Cranes.

STUDY AREA

Uttar Pradesh

Most of Uttar Pradesh falls under the biogeographic zone 7A of the Upper Gangetic Floodplains and contains an area of approximately 2,55,000 sq. km of floodplains (Rodgers and Pawar 1988). The principal rivers of the floodplains are the Ganga, Yamuna (also spelt 'Jamuna'), Sharda and Ghagra. Many types of vegetation and wetlands are found in this area. The principal wetland types found in the State include tropical seasonal swamps (terai), tropical seasonal marshes (*chaurs* of the plains), oxbow lakes, seasonally inundated wetlands (*jheels* and *tals*), and riverine wetlands (Scott 1989). These areas are characterised by fertile, alluvial soil with very high water retention capability. The State has a very high population of humans with density ranging from 500 to 700 people per sq. km (Anon. 2001). The principal occupation of over 78% of the population is agriculture. The varied habitats in the region have made it possible for a very high diversity of flora and fauna to exist in the State. Over 400 species of angiosperms have been identified in the State. Among fauna, there has been documentation of 57 fish species, 11 turtles, over 600 species of birds, and many mammals of conservation concern. The region is known to possess some of the best remaining wetlands in the country, which are home to very large numbers of waterbirds in the winter, and which provide a breeding habitat to many resident species of waterbirds as well (Scott 1989).

Etawah and Mainpuri

Intensive fieldwork on the ecology of the Sarus, to determine the importance of natural wetlands to Sarus Cranes, was conducted in the border areas of Etawah and Mainpuri districts of Uttar Pradesh. The study area encompassed the towns of Etawah, Karhal, Saman and Baralokpur, and included an area of c. 500 sq. km (Fig. 1). This region comprises a part of the lowlands of the Gangetic floodplains that is extremely flat and very homogenous (Scott 1989). This area is well known to have many wetlands that are an important refuge for

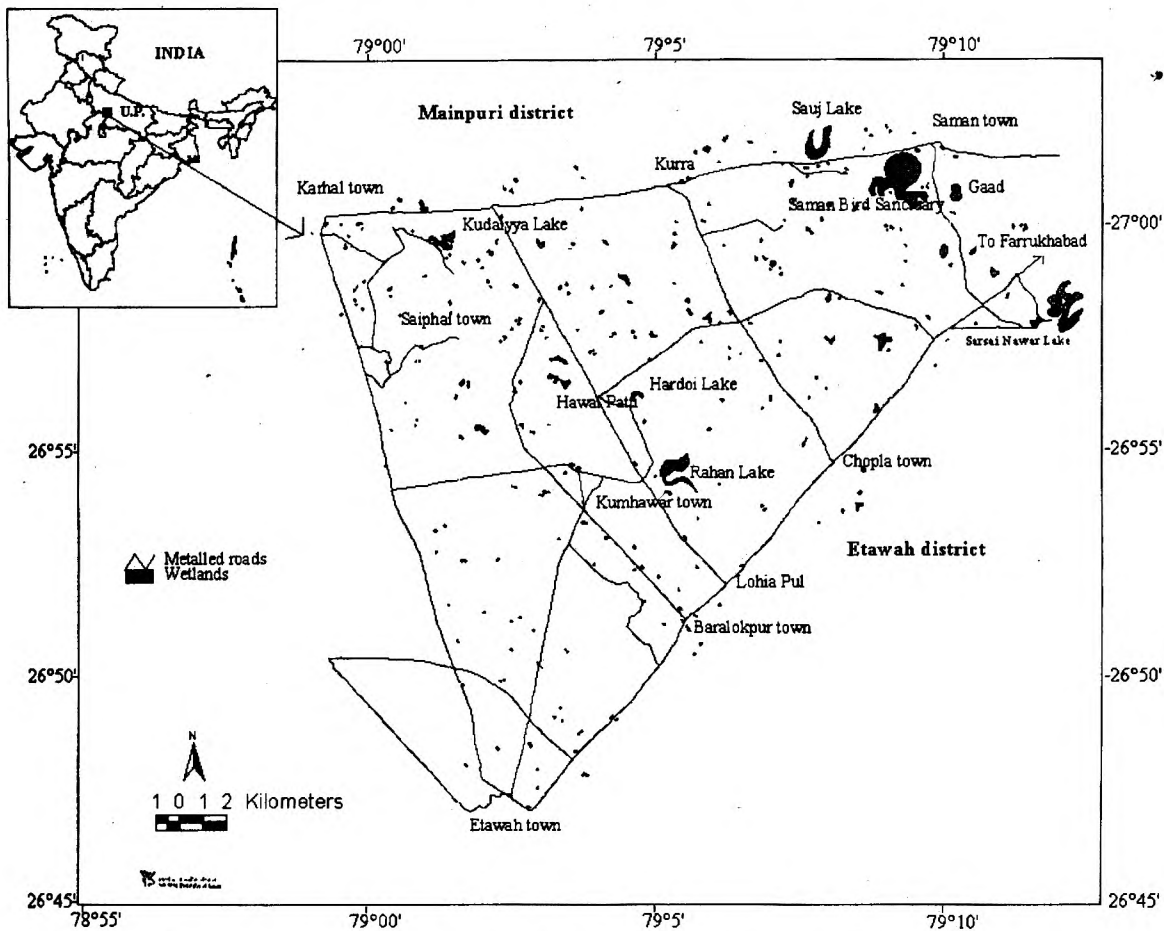


Fig. 1: Intensive study area in Etawah and Mainpuri, Uttar Pradesh. The metallised roads used to traverse the area during the study and the natural wetlands are shown. Only principal towns and wetlands have been named

wintering waterbirds (Scott 1989). The landscape was a mosaic of natural wetlands, crop fields, irrigation canals, and human habitation and associated structures. Trees were thinly dispersed all over the landscape. The principal crops in the region were rice *Oryza sativa* during the monsoon and wheat *Triticum aestivum* in the winter. Breaches in the irrigation canals resulted in the formation of many wetlands that resembled wetlands formed by flooding of rainwater. Three seasons could be differentiated based on temperature and rainfall regimes, namely summer (March to June), monsoon (July to October) and winter (November to February). Most of the precipitation in the area was from the southwest monsoon in the months of July to October with an annual average of 882 mm of annual rainfall (average for 1990-2001), and the temperature varied between 1 °C and 50 °C (District Magistrate's Office, Etawah, pers. comm.).

SCOPE AND METHODS

This paper provides an assessment of the importance of the State of Uttar Pradesh to Sarus Cranes, using the

information of previous all-India surveys and all-India counts conducted by WII. In addition, the preliminary results of the detailed ecological study undertaken in Etawah and Mainpuri are highlighted, paying attention in particular to aspects that would be necessary to prepare a practical conservation action plan. The aspects that are covered for this paper are described below, along with a brief description of methods.

1. Relative abundance, distribution and breeding areas in Uttar Pradesh: The information from the all-India survey of the WII (Sundar *et al.* 2000b), and that derived from the three all-India Sarus Crane counts (Choudhury *et al.* 1999; Sundar *et al.* 2000a; Kaur *et al.* 2002) have been used to prepare a distribution map of Sarus Cranes in Uttar Pradesh. Breeding areas were also determined from the same sources. Non-parametric Kruskal-Wallis (K-W) χ^2 tests were used to determine differences in encounter rates of Sarus Cranes across states in which they occur.

2. Effect of territory quality on breeding success: Proportion of wetlands within a territory was considered as the parameter determining territory quality. The extent of the territories were ascertained from December 1999 to July 2002,

with at least 50 observations of each territorial pair over a minimum of three seasons. Some pairs were identified individually by placing exclusive combinations of plastic colour-bands on the young birds, while most of the others were identified by location, and a few by physical marks on the adults or young birds. Actual extent of territories was ascertained by observations of agonistic interactions of neighbouring pairs, and territories were assigned into classes depending on amount of wetlands, i.e. 0-10%, 11-20%.... 91-100% wetlands in territories. Territorial breeding pairs could be observed for one, two or three breeding seasons and breeding success is defined as the mean number of young dispersing from their natal territories for the observed duration. Amount of natural wetlands in each territory was assessed between October and November 2001. Dispersal of young was monitored for three seasons (1999-2000, 2000-01 and 2001-02). The distribution data of the mean number of young dispersing successfully from their natal territories were not uniform (One-sample Kolmogorov-Smirnov test, $p < 0.0001$). Non-parametric K-W χ^2 tests were used to see the effect of territory quality on breeding success.

3. Habitat use and preference: We studied use and preference of habitats for both nests as well as Sarus Crane adults. Two nesting seasons were covered (2000 and 2001) and habitat use/ preference by adults was studied between January 2001 and February 2002. Broadly, four habitat types were recognised, namely crop fields, irrigation canals, natural wetlands and other miscellaneous habitat types. For each nest, the habitat in which they were constructed in was noted. Habitat use by adults was determined by laying out a road transect of 105 km each month. Availability of habitat was determined along the transect. All habitat types on either side of the road were enumerated and proportion of availability of each habitat type was determined after summing up all the frequencies each month. Habitat preference/ avoidance was determined each month using the non-mapping technique described by Marcum and Loftsgaarden (1980).

These aspects are discussed alongside known information on the Sarus' biology from other states to illustrate

the importance of Uttar Pradesh for the species, and to obtain a holistic view on the cranes' biology in order to better plan conservation actions.

RESULTS

Relative abundance, distribution and breeding areas in Uttar Pradesh

In comparison with other states in which surveys and counts were conducted, the number of Sarus Cranes in Uttar Pradesh was always found to be higher (Table 1). In 2001, reports from Gujarat and Rajasthan were very few, and counts in Uttar Pradesh increased, making it appear as if the State is home to more than 88% of the Sarus Cranes in the country. On an average, however, irrespective of method used, around 40-53% of the country's Sarus Cranes were counted from Uttar Pradesh (Table 1). The proportion of young birds counted was around 10%, rarely exceeding 15%. Encounter rates obtained in the four major states with Sarus Cranes, namely Gujarat, Rajasthan, Madhya Pradesh and Uttar Pradesh, during the 1998-99 survey (Sundar *et al.* 2000b), were significantly different across seasons (Mann-Whitney $U = 1798.5$, d.f.=3, $p = 0.036$), and differences across states were analysed seasonally. Encounter rates were found to be significantly different across states in the winter, but not so in the summer, though mean values for both seasons were the highest in Uttar Pradesh, being more than twice the encounter rates in other states each season (Table 2).

A map of relative abundance of Sarus Cranes was developed using information from the Sarus Crane Counts. Most Sarus were seen to be concentrated in the western and central portion of Uttar Pradesh, with very few cranes being reported from the northern and eastern parts of the State (Fig. 2). This is more or less consistent with what was reported in the two all-India surveys of Sarus Cranes, only there are many more areas with Sarus in the eastern portion of Uttar Pradesh, but with far lower populations than seen in the other areas in the west and central Uttar Pradesh (see Sundar *et al.* 2000b). Sarus were reported breeding almost throughout the State (Fig. 3).

Table 1: Importance of Uttar Pradesh (U.P.) with respect to Sarus Crane *Grus antigone* population and recruitment.
Data is from all-India surveys and all-India volunteer Sarus Crane Counts

Reference	Method	Total no. of Sarus counted	% of Sarus counted in U.P.	% young in U.P.
Gole (1989)	Survey	1247	52.9	11.4
Choudhury <i>et al.</i> (1999)	All-India count	1991	51.2	15.6
Sundar <i>et al.</i> (2000a)	All-India count	2669	52.4	11.8
Sundar <i>et al.</i> (2000b)	Survey	1761	39.8	10.0
Kaur <i>et al.</i> (2002)	All-India count	3315	88.5	10.0

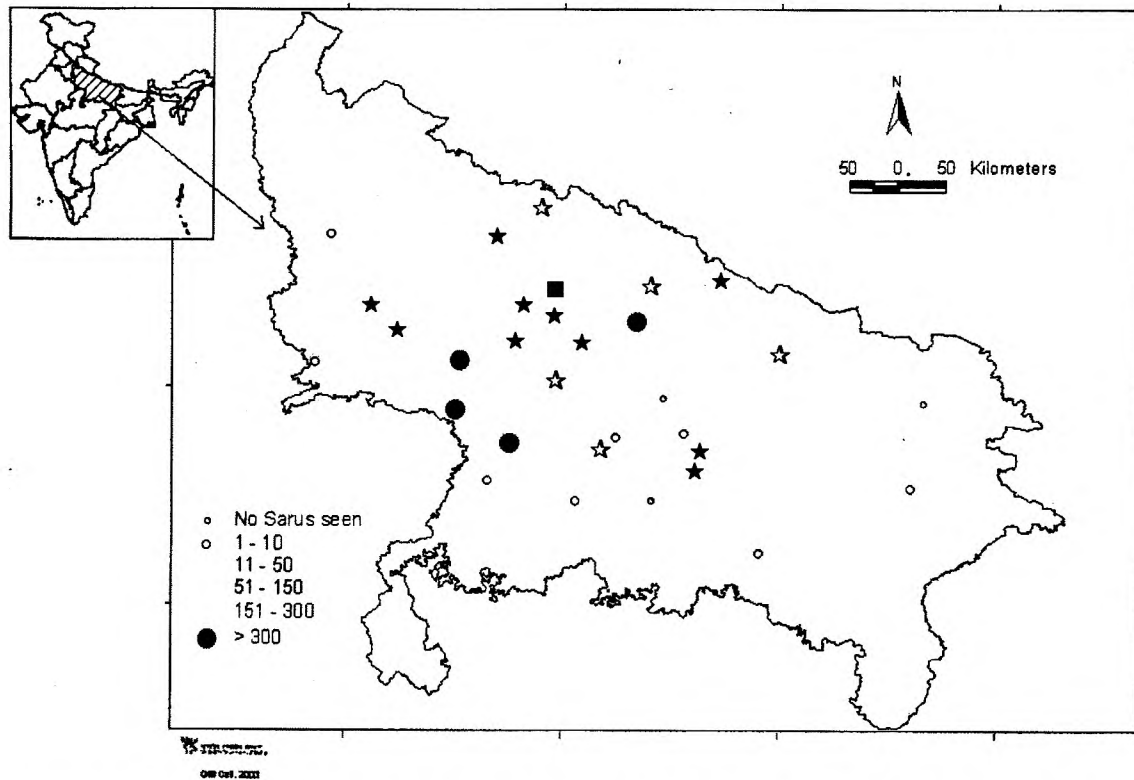


Fig. 2: Relative abundance of Sarus Cranes *Grus antigone* in Uttar Pradesh (Source: All-India Sarus Crane Counts)

Effect of territory quality on breeding success

Nearly 250 territorial breeding pairs were monitored for a total of 508 Sarus Crane years. No territory was composed entirely of natural wetlands, while for a few ($n=42$), the extent of territories could not be accurately determined and therefore the amount of natural wetland could not be ascertained. Most of the territories had less than 20% of their area as natural wetlands ($n=209$, Fig. 4), and only 35% had perennial wetlands ($n=249$; Fig. 5).

A total of 206 young birds were seen to successfully disperse from their natal territories. Mean number of young birds dispersing successfully per year from natal territories was significantly higher in territories with more natural wetlands ($n=209$, K-W test, $\chi^2=8$, $p<0.001$; Fig. 6), with the highest success seen in territories with 40-60% natural wetlands. The mean number of chicks dispersing successfully was nearly double from territories that had perennial wetlands as compared to territories with non-perennial wetlands ($n=249$, Mann-Whitney $U=5463$, $p=0.001$; Fig. 7).

Habitat use and preference: Nests

A total of 128 nests were investigated for habitat use and preference, 54 in 2000 and 74 in 2001. Each year 32% of the nests were found in paddy fields, while most of the nests were found in natural wetlands in both years (2000: 57%, 2001: 61%; Fig. 8). The rest of the nests were on dykes

separating paddy fields and natural wetlands. Nests were not found in any other habitat. In the nesting months (July to October), an average value of the various habitat types available was calculated and used to represent availability. In Etawah and Mainpuri districts, the Sarus Cranes preferred natural wetlands as nesting sites (Fig. 8).

Habitat use and preference: Adult Sarus Cranes

Habitat preference was calculated for groups of one or more Sarus Cranes seen together to avoid problems with non-independence. However, information for total number of cranes seen in each habitat type is also represented as a comparison. Between 51 and 107 groups comprising between 112 and 955 individual Sarus Cranes were sighted in the road transects. For data using groups, except for March, April and December 2001 when habitats were used in proportion to their availability (χ^2 tests, $p>0.05$), there was some choice exercised in all the other months (χ^2 tests, $p<0.05$). Natural wetlands were used by more groups only in July and October 2001, while in all the other months with disproportional usage of habitat, crop fields were preferred (Fig. 9). Though statistical tests could not be carried out, when data of total number of cranes using a particular type of habitat were analysed, crop fields were preferred much less, even avoided in some months, while natural wetlands were used by more numbers of cranes in almost all the months (Fig. 10).

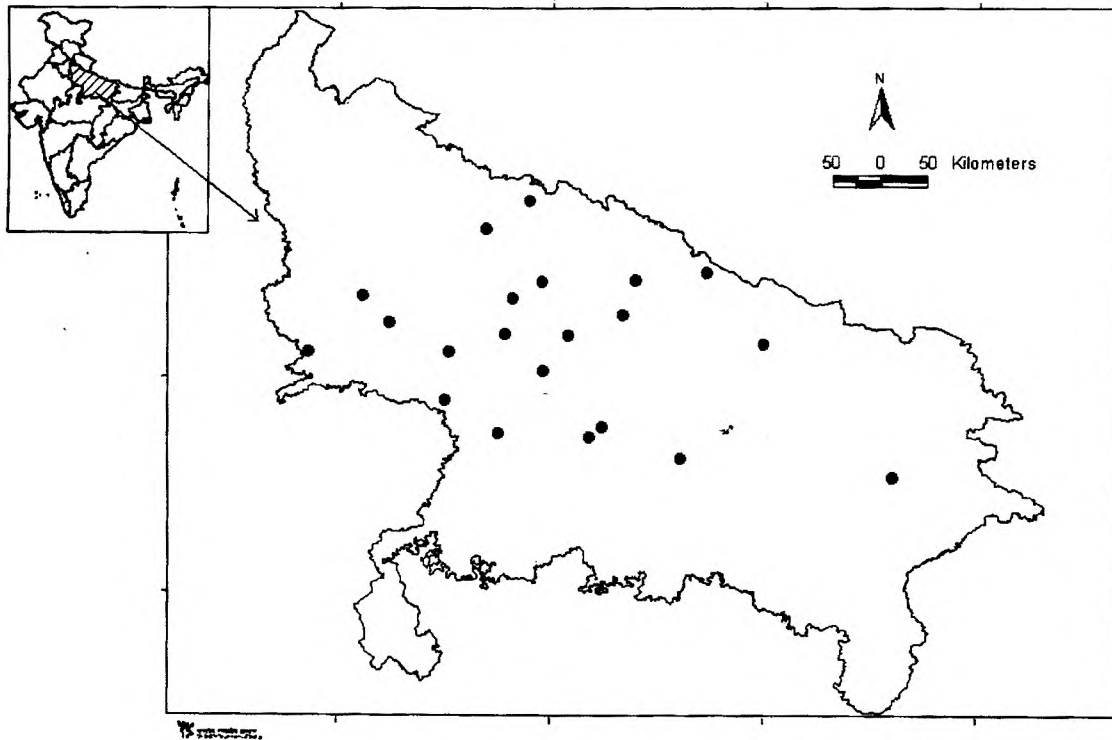


Fig. 3: Breeding areas of the Sarus Crane *Grus antigone* in Uttar Pradesh (Source: All-India Sarus Crane Count)

DISCUSSION

Importance of Uttar Pradesh for Sarus Cranes

The information gleaned from all-India surveys and counts clearly indicates that Uttar Pradesh is the most important state for Sarus Cranes (Tables 1 & 2). The proportion of young reported in the State each year is almost constant, indicating continuous breeding and recruitment. Most crane species are known to have 5-20% of young in their population (Allan 1993) and this compares well with the Sarus Cranes in Uttar Pradesh. The number of Sarus Cranes in the eastern and northern areas were low and this is perhaps attributable to the fact that sugarcane is the chief crop in

these areas. Sugarcane neither provides any habitat nor food for the Sarus Crane. Much of the cranes counted each year were in the districts of Etawah and Mainpuri, where the cropping cycle is summer paddy and winter wheat. This appears to be the most suitable land use practice for Sarus Crane habitat. There were no significant differences in encounter rates across states in summer, and the habit of cranes to flock in the last remaining wetlands may have contributed to a uniform low encounter rate in this season. The encounter rate in winter, however, was significantly higher in Uttar Pradesh indicating that the road count method may be useful to determine relative abundances across large areas.

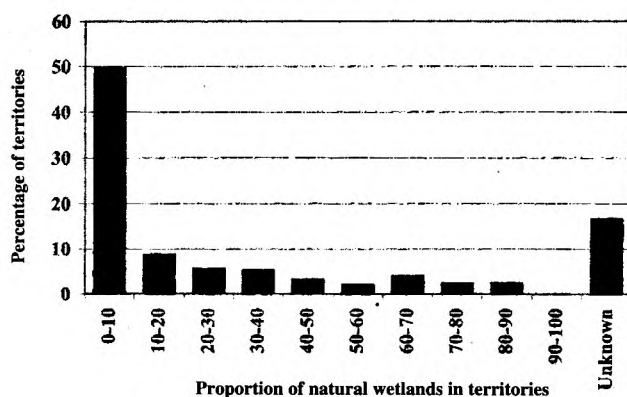


Fig. 4: Sarus Crane *Grus antigone* territory quality: Extent of natural wetlands in territories

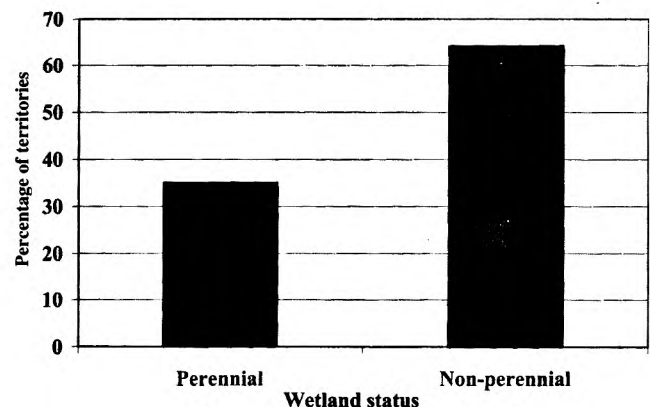


Fig. 5: Sarus Crane *Grus antigone* territory quality: Perennial vs. non-perennial wetlands in territories

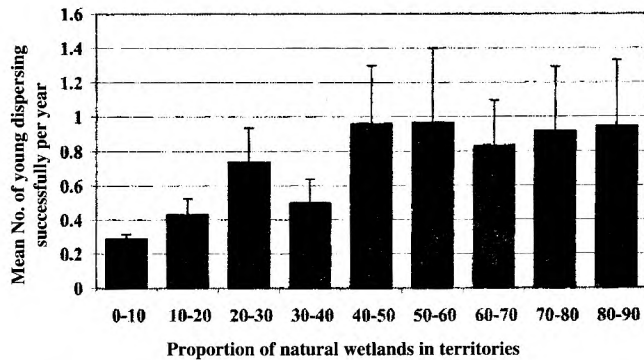


Fig. 6: Effect of extent of natural wetlands in Sarus Crane *Grus antigone* territories on breeding success (Bars indicate Standard Error)

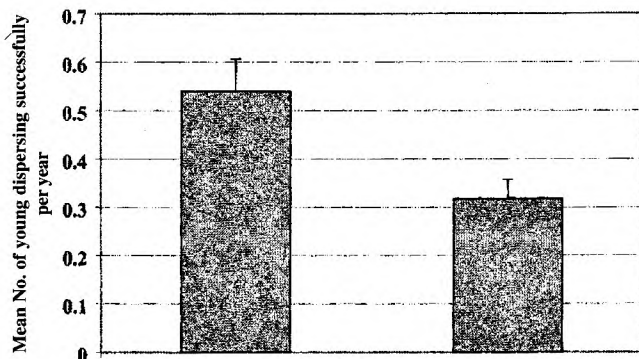


Fig. 7: Effect of type of natural wetland in territories of Sarus Cranes *Grus antigone* on their breeding success (Bars indicate Standard Error)

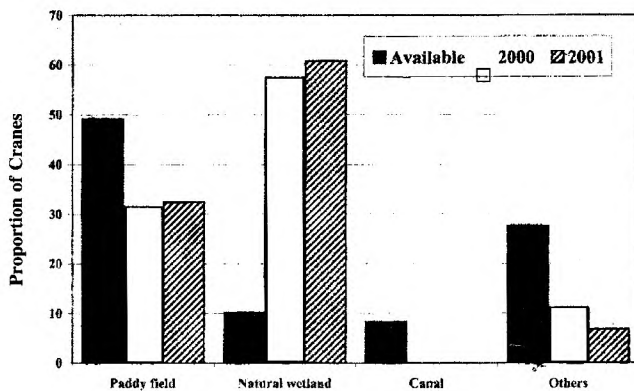


Fig. 8: Habitat use and preference by Sarus Cranes *Grus antigone*: Nesting sites

Importance of natural wetlands to Sarus Cranes

The study in Etawah and Mainpuri districts clearly demonstrates that natural wetlands are crucial as breeding habitats for Sarus Cranes. Not only are they preferred habitats for constructing nests in, but are also needed in territories to ensure maximum breeding success. Sarus Cranes are omnivorous. In Etawah and Mainpuri, they have territories less than half a square kilometre in size. This is the smallest

size known for Sarus Crane territories and is an indication of a superior habitat. Post-fledging mortality in the study area was negligible (K.S.G. Sundar, pers. obs.) indicating that territory quality plays a major role only until the fledging stage of young cranes. Natural wetlands provide good cover for young birds until they fledge, while in crop fields, the paddy is harvested in November when the chick is still vulnerable. Also, many farmers maintain dogs to guard fields, which hunt down pre-fledged chicks frequently (K.S.G. Sundar, pers. obs.). Natural predation of Sarus Cranes was minimum in the study area. The habitat use/preference by Sarus Cranes illustrates that crane groups used crop fields the most. However, when individuals were considered, natural wetlands were used the most almost throughout the year. This was primarily because the flocks mainly used natural wetlands and they constituted more than 50% of the population in any month (K.S.G. Sundar, pers. obs.). Thus, natural wetlands were seen to be the most important habitat.

Implications for conservation of Sarus Cranes in Uttar Pradesh

The information collected during this study has clear implications for the conservation of the Sarus Cranes in India and in Uttar Pradesh. The potential role of wetlands as preferred habitat for the Sarus Crane was strongly suspected, and the empirical information of this study provides conclusive evidence. Large wetlands in the landscape are required for non-breeding flocks until they find mates and territories of their own. They constitute more than 50% of the population of Sarus Cranes (unpublished information). However, small and scattered wetlands are crucial habitats that enhance breeding success in Sarus Cranes. Uttar Pradesh is one of the few states in India with a good number of natural wetlands still available, though most of them are exposed to various degrees of human disturbance. Many are rapidly being drained to make way for crop fields, and the negative impact of such rapid agricultural changes on farmland birds and biodiversity in general has been widely acknowledged and has become an international conservation concern in recent years (McLaughlin and Mineau 1995; Siriwardena and Schifferli 1998). While for many species the world over, declines have been apparent due to intensification of agricultural practices, a lack of knowledge on specific factors has prevented application of conservation practices to save them (Siriwardena and Schifferli 1998). For the Sarus Crane, this study has made it abundantly clear that the extent and type of wetlands in territories affect breeding success, and preservation of the Sarus Crane in the State will only be possible with the preservation of the natural wetlands of the State. These wetlands are mostly outside the purview of the

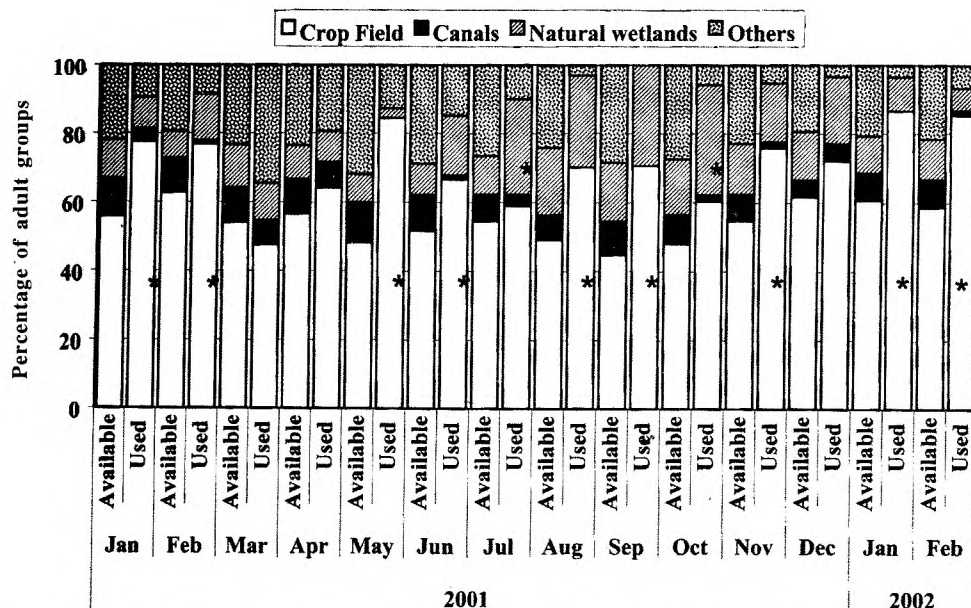


Fig. 9: Habitat use and preference by Sarus Cranes *Grus antigone*: Adult groups. Preference of particular habitat types each month (marked by *) was inferred from 95% Bonferroni's confidence intervals

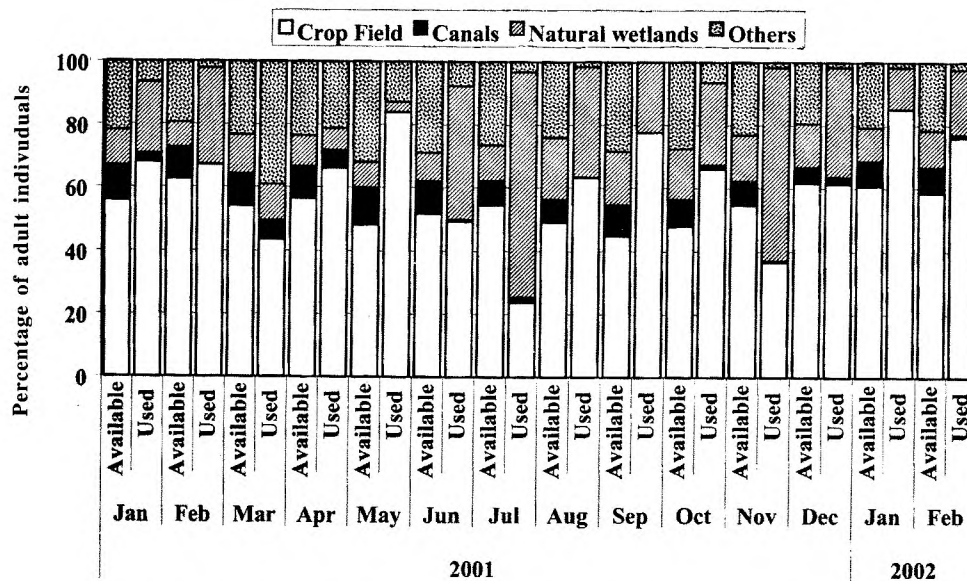


Fig. 10: Habitat use and preference by Sarus Cranes *Grus antigone*: Adult individuals

Department of Forests and Environment. The other departments of the State such as Rural Development, Irrigation, Agriculture and related departments should be included in conservation action plans for the Sarus Crane.

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